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On the Theory of Saturn and the Mass of Jupiter.

M. Leverrier has communicated to the Academy of Sciences at Paris (*Comptes Rendus*, t. 81, pp. 349 and 381, August 23 and 30, 1875,) two Notes on the Comparison of his theory of *Saturn* with observations, and on the Mass of *Jupiter*.

As regards *Saturn*, the general result is that during the thirty-two years of modern observations, from 1837 to 1869, the difference between theory and observation is always below $2''\cdot5$ of arc (less than $0^s\cdot2$ in the times of transit), with the exception of the two years 1839 and 1844, for which the differences attain to $4''\cdot5$ of arc ($0^s\cdot3$ in the times of transit). It is only in the ancient observations, in the times of Maskelyne and Bradley, that there are some rather larger differences.

The accordance is thus good from 1846 to 1869; the only disquieting circumstance is in the somewhat abrupt change in five years, from a difference of $+4''\cdot4$ in 1839 to $-5''\cdot0$ in 1844, a change of $9''\cdot9$ in five years, according to the Greenwich Observations, or $9''\cdot5$ according to the Paris Observations. M. Leverrier is led to conclude ("nous sommes porté à conclure") that the error is due not to the theory, but to the observations: he considers that the varying aspects of the ring may have affected the observations of the times of transit, and have produced in the personal equations of the observers perturbations sensible enough in the ancient observations, but which have gradually diminished with the improvement in the system of observations.

As regards the Mass of *Jupiter*, Laplace (1802), from observations by Pound of the elongation of the fourth satellite, obtained the value $\frac{1}{1067\cdot09}$: Bouvard (1824), by means of his tables founded on the formulæ of the *Mécanique Celeste*, and by a comparison of the motions of *Jupiter*, *Saturn*, and *Uranus*,

with the observations during seventy-four years (1747 to 1820), obtained the value $\frac{1}{1070{\cdot}5}$; and Airy (1835), by a new series of observations of the fourth satellite, the value $\frac{1}{1046{\cdot}77}$: this last, and $\frac{1}{1050}$, are the values used in M. Leverrier's comparison of the theories of *Saturn* with the observations.

M. Leverrier inquires how it was that Bouvard was able to derive from the theory of Saturn compared with the observations of seventy-four years an inexact value of the mass of *Jupiter*; and one so nearly the same with that given by Pound's observations of the fourth satellite.

Using the 120 years of observation at his disposal in an attempt to find a correction of the mass of *Jupiter*, he finds that the influence of the indeterminate correction, μ^{iv}, of this mass, on the four elements, mean longitude, mean motion, eccentricity, and longitude of perihelion, is considerable; but, nevertheless, the form of the equations is such that on eliminating from the equations of condition the principal unknown quantities, the coefficients of μ^{iv} in a great measure destroy each other in the residual equations, and assume values which are nowhere the tenth part of what they were in the original equations: and that thus the precision which might have been expected for the determination of μ^{iv}, that is the correction of the mass of *Jupiter*, disappears.

And this is the case even for the 120 years of observation, while Bouvard had only the observations of 74 years: the data for Bouvard's investigation were thus absolutely insufficient.

How then did it happen that he found nearly the same mass as had been obtained from the early observations of the fourth satellite, thereby furnishing to Laplace the elements of an illusory calculation as to the great probability of the exactness of the results?

Bouvard gives no explanations of his process, but he must have started from the then received mass of *Jupiter*: and M. Leverrier considers that any mass whatever, assumed at pleasure within certain limits, permits of a sufficiently good satisfaction of the observations of *Saturn*, under the condition that this arbitrary mass is introduced consistently in the functions which represent the above-mentioned four elements; and that thus Bouvard could not but obtain for the mass a value nearly the same as his assumed one.

M. Leverrier's conclusion is: the employment of the elongations of the fourth satellite, for the determination of the mass of *Jupiter*, has at present an incontestable superiority over the employment of the theory of *Saturn*, on account of the insufficient period of the observations of *Saturn*: but in the course of years this superiority will diminish, and the employment of the observations of *Saturn* will have the advantage when, these perturbations having changed their sign, there remain in the

residual equations coefficients of μ^{iv} equal or superior to those of the original equations. The case is the same as in the question of the Sun's parallax, obtainable by the two methods, the transit of *Venus*, and the perturbations (for instance) of *Mars*: the method of Transits, so important at the epoch of 1760, but limited in its means, must give way ('doit fatalement céder la place') to the method of perturbations, the exactitude of which is continually increasing.

Remarks on Drawings of Jupiter made by Miss Hirst, at Auckland, New Zealand. By S. J. Lambert, Esq.*

On behalf of Miss Hirst, a lady resident in Auckland, New Zealand, who has been engaged in astronomical work for the last sixteen years, I beg to lay before the Royal Astronomical Society some of her notes on the last opposition of *Jupiter*, 1875.

The instrument she used was a Browning's $8\frac{1}{2}$-inch silvered-glass reflector, and the powers used were Browning achromatic eye-pieces of 144, 208, and 250. The information may be relied upon, as she is both a practical and a careful observer. She has made use of the diagrams used by Lord Rosse, in the *Monthly Notices* for March 1874, where the dark bands are designated by figures, and the bright spaces by letters. With these notes I send you a few of her drawings of *Jupiter*, all of which were made during the observations on the respective dates.

Her diary contains some valuable information on Meteoric Showers, observed in Auckland, which I will send you at some future time.

Zone 1.—The South Polar Zone has exhibited some signs of change during the recent opposition. On February 5, at $4^h\ 19^m$, G.M.T., this zone was seen divided longitudinally, near the pole of the planet; with aperture reduced to 6 inches, a number of small dark spots were visible on the surface of this zone, whose centres were extremely black. During this observation the definition was sharp, and the air steady. This zone has appeared decidedly fainter than last season. On February 20, at $3^h\ 59^m$, G.M.T., a small oval patch of a decided sea-green was visible a little to the east of the pole, which on the following morning was more elongated, and a shade darker in the centre. It remained thus for three days, and has not since been seen.

Zone *a*.—On many mornings lately, this bright band has been sharply defined. On March 17, at $2^h\ 36^m$, G.M.T., a dark streak, broken in two places, ran along the centre of this zone. Later on, in the morning, it became one continuous line, but of

* These drawings are preserved at the rooms of the Society, where they can be inspected by any Fellow desirous of comparing them with other drawings of *Jupiter*.

an irregular thickness. The same phenomenon was observed on April 7, at $3^h\ 1^m$, G.M.T.

Zone 2.—This zone has displayed more evidence of change than any other during this season. Sometimes it has presented an entire mottled appearance, as on the morning of March 30. Once it was only seen as a narrow patch on the central meridian, the extremes running into the bright band *b*, and on April 30 it had disappeared altogether, but presented itself again on the following morning. On May 6, it was decidedly darker in colour, while its western extremity curved down into the equatoreal zone, having a white cloudy patch on its opposite extremity.

Zone *b*.—Miss Hirst recorded as follows, with regard to this zone, and I give it in her own words:—"While examining the planet on the morning of April 20, at $1^h\ 25^m$, G.M.T., with power 208, definition being exceedingly good, I thought I detected a dark spot in zone *b*, near the equatoreal zone. Thinking this object would improve on reducing the aperture, I put on a 6-inch stop, and used power 144. This spot then came out in great brilliancy, accompanied with three others on the same zone, but smaller than the first, though equally brilliant. I searched for them again many times afterwards, but only saw them once more, when definition was similar to that on the above date."

South Tropical Belt, 3, I.—The bright division in this belt has been noticed to vary very much in width, and at times to be in various parts filled in by the equatoreal belt. On some occasions the northern edge of this division has appeared much darker; and on June 4, at $22^h\ 15^m$, G.M.T., this portion of the equatoreal zone contained two bright divisions of equal width, each narrower than the division generally visible.

The Equator, 3, II.—Some very curious phenomena have been observed in this region of the planet. In the central bright band of this zone dark spaces have been observed, generally of an oval form, some of them having dark borders, while others had none. It has also been noticed that the eastern border was always the darker of the two. The first sight of these bright spaces was obtained on the evening of May 1, at $21^h\ 45^m$, G.M.T.

Zone 3, III.—This zone has been frequently seen with large gaps breaking into *c*, whose southern borders have sometimes been of a dark lead colour. On two occasions a bright spot was observed in the centre of one of these breaks, as on April 5th and 20th.

Zone *c*.—This zone has certainly appeared much brighter than last year. A curious dark spot was seen near its eastern extremity, on April 7, at $21^h\ 5^m$, G.M.T., but on the following night was missing.

Zone 4.—A peculiar faintness has characterised this North Temperate Belt on many occasions this year. At times it has appeared very distinctly marked, and more especially on its northern edge. Frequently no division could be detected between it and Zone 5, and on very few occasions has it been seen to advantage.

Zone *d*, has still been narrowly defined, but not so much so as last year. At times it has appeared much brighter than at others, but generally ill defined.

Zone 5.—This Polar Zone has not undergone much apparent change since last year. Twice a narrow and very dark belt has been seen running across it; and once, when it was very conspicuous, a small narrow projection was noticed, obliquely uniting 4 with 5. Nothing of this kind was noticed last year in this locality.

The colours of *Jupiter* this year have been more varied than usual, and, on the best nights for definition, have appeared decidedly darker than formerly. Only on two occasions were Mr. Lassell's bright spots detected, and then with a reduced aperture, on the southern belts; and at those times the planet was near opposition, and definition more than ordinarily good.

The transit of the Satellites, with their shadows, have been noticed on many occasions. The most curious phenomena have been indicated by Satellite III. It has frequently appeared as a dark spot when near mid-transit, but on nearing either edge has appeared bright. At times the satellite presented an elongated appearance east and west, while its disk was dark, as in mid-transit, but has been noticed to gradually assume its general outline as it neared the edge of the planet: this was specially noticed on April 9. The same thing has repeatedly been seen with Satellites I. and II., but was less marked than with Satellite III. On one occasion Satellite I. was observed slightly elongated when near mid-transit, but like III. returned gradually to its proper shape while nearing the edge of the disk.

The weather in Auckland for nearly two months before opposition was all that could be desired for observation, but after that date cloudy and unsettled weather set in. Thus the original system of observation was broken, and finally for the season had to be abandoned.

Note on a certain Structure in the Umbræ of Solar Spots.

By Colonel Tennant, R.E.

(*Extract from a Letter to Warren De La Rue, Esq.*)

"On June 28 I sent you a description of what I had seen of the Sun. I said I was not sure about a certain *structure* in the umbræ of solar spots. Curiously enough, I have found since a communication from Mr. Langley (*Monthly Notices*, Vol. xxxiv., p. 255), which goes over much of the same ground.

"As to the 'rice grains,' it is quite clear that they are not *smooth-surfaced*. Hence one sees light and shade on the surfaces, and the degree is very variable even with slight changes of shade.

I use an achromatized dark prism, which is the only way of getting sufficient command over the tint of the surface. The swelling, as it were, of the grains when more light is admitted, and their contraction when a darker tint is used, are marked; and I can think of no better description than that I gave you for their appearance, that is, the appearance of an attempt at a flat tint on very rough drawing-paper. This is of course closely analogous to Herschel's, of a subsidiary flocculent precipitate, and must be so from the way paper is made.

"As to penumbræ, I cannot say so much: they have always seemed to me more filamentous than what I understand you (*Memoirs*, Vol. xxxiii.) as rice-grains. I have been mostly attracted by the *umbra*, and thus have used more light probably than was best for penumbra; but the appearance has been rather of fascines of semi-transparent sticks, which I took for blurred willow-leaves. I will pay more attention in future to the appearance of these. The view with my strong light is very beautiful. I sometimes almost felt as if a spot were the entrance of a deep cave bordered by brilliantly-lighted icicles.

"The most remarkable thing in Mr. Langley's letter is his description of umbra structure. 'Filaments of immeasurable fineness are at times seen projected on the umbræ, looking collectively like carded wool,' p. 258. 'The whole umbra is seen at times to be nearly or wholly made up of sunken banks of the filaments,' p. 259. You will note that this is almost identical with my description in my letter to you—'a thin flock of cotton wool on black velvet.' Surely I, with a 6-inch aperture, and Mr. Langley, with a 13-inch, have seen the same thing."

Colonel Tennant remarks in the same letter that he has had good views of *Saturn* and *Mars*. "The same evening that I observed *Saturn*, crape ring, and all, I saw the companion of *Antares* staring; and on two occasions lately I have seen *Mars* well. I have several times looked for the companion of *Antares*, but I never before could get it clear of the blurr. So you will judge that I do not get much definition as a rule."

Roorkee, 1875, *August* 16.

Note on the Position of the Equinoxes. By Prof. Simon Newcomb.

In the *Monthly Notices* for May 1875, page 350, an erroneous statement is attributed to Dr. Gyldén, which, though unimportant in itself, may tend to spread a serious misapprehension respecting the position of the Equinox, to be deduced from the observations of the Sun made at the principal Observatories. The discordance of the results for the position of the Equinox may be seen from the following table, which shows the outstanding corrections to the Right Ascensions given in my paper in the

Washington Observations for 1870, which result from the observations of the Sun made at the several Observatories. They are deduced from the data given in § 5 of the paper referred to.

	s	Weight.	Years.
Greenwich	−0·028	18	1836–70
Pulkowa	−0·019	5	1842–50
Edinburgh	0·000	4	1836–43
Cambridge (Eng.)	+0·006	8	1833–56
Paris	+0·025	6	1854–65
Washington	+0·038	8	1862–69

The weights are those I actually assigned in the determination of the Equinox. As each series of observations is copiously discussed in the paper referred to, I am unable to account for the statement that I have *probably* omitted Paris, and given very great weight to Washington. A slightly greater weight was given to observations where the Sun culminates at a high altitude the entire year, and this course seems to me entirely justifiable.

As Dr. Gyldén's Right Ascensions are $0^s{\cdot}017$ less than mine, the corresponding corrections to his Equinox would seem to be—

	s
Greenwich	−0·011
Pulkowa	−0·002
Edinburgh	+0·017
Cambridge (Eng.)	+0·023
Paris	+0·042
Washington	+0·055

This discordance of the Equinoxes derived from the Greenwich and Washington Observations is something I am entirely unable to account for, more especially as it has, without the slightest alteration, survived a complete change of instruments in each Observatory. The state of the case seems to be that: while the two Observatories give the same result for the Sun's absolute Right Ascension, or for the moment of the Equinox—in comparing the Sun with stars, the Greenwich differences (⊙'s R.A. − ∗'s R.A.) is constantly 1″ greater than that observed at Washington.

Corrections to Professor Gyldén's List of Right Ascensions of 103 *Fundamental Stars, May Number, pp.* 349–356. Communicated by Prof. A. D. Wackerbarth.

"In the Right Ascensions themselves there is only one erroneous figure, the R.A. of *ζ Aquilæ*, which ought to be

"p. 353, col. 1. $18^h\ 59^m\ 39^s{\cdot}848$.

" In the table of the differences from other Catalogues, the following figures should be introduced, instead of [or besides] those printed :—

	Star.	S−P.	S−B.J.
"p. 353.	η Piscium	+0·028	
	ξ^2 Ceti	+0·029	
	γ^2 Ceti		−0·060
p. 354.	α^2 Geminorum		+0·055*
	6 Cancri	+0·011	
	12 Can. Venat.		−0·051
p. 355.	α Aquilæ		−0·053
p. 356.	γ Piscium	+0·010."	

" * A.R. in B.J. holds for mean."

" *Uppsala*, 1875, *July* 25."

Observations of Coggia's Comet (III, 1874).

By John Tebbutt, Esq.

Some months ago I sent the differential observations of Coggia's Comet (III, 1874). The comparison-stars, with the exception of two, have been since observed with the Melbourne Transit-circle, and their mean positions for 1875·0 kindly communicated to me by Mr. E. J. White, the acting Government Astronomer. The places of the comparison-stars employed on August 24th and Sept. 7th will be determined at some future opportunity. I have reduced the mean places to 1874·0, and thence obtained the apparent places for the dates of the comet-observations by means of the independent quantities on pages 330–337 of the *Nautical Almanac*. I have now much pleasure in communicating the resulting apparent Right Ascensions and North Polar Distances of the comet. I detected Encke's Comet by sweeping, without the aid of an Ephemeris, on the morning of the 7th ult. I have since found that both Sydney and Melbourne had been supplied with an Ephemeris, though, for some unaccountable reason, Windsor has been neglected in this matter. As I am anxious to do what lies in my power for the due observation of Southern Comets, I shall be glad at all times to receive Ephemerides of these bodies.

Windsor Mean-Time, 1874.				Comet's App. α			Comet's App. Δ		
	d	h	m	s	h	m	s	°	′	″
Aug.	1	17	15	39	7	57	16·71	121	54	25·0
,,	,,	17	44	38	7	57	17·43	121	57	27·4
,,	2	17	23	2	7	57	56·96	124	33	24·4
,,	,,	17	28	47	7	57	56·89	124	34	13·9
,,	6	6	15	40	8	0	21·26	132	3	37·1
,,	,,	6	15	40	8	0	20·25	132	3	49·1
,,	7	6	19	17				133	46	16·1
,,	,,	6	23	49	8	1	5·52			
,,	13	6	34	54	8	5	23·42	141	28	20·0
,,	14	6	43	41				142	27	8·6
,,	,,	6	51	37	8	6	5·33			
,,	18	16	14	29	8	9	0·36	146	3	47·8
,,	,,	16	26	41	8	9	1·09	146	3	53·8
,,	20	6	59	33	8	9	54·68	147	10	10·8
,,	22	7	7	10	8	11	3·24	148	26	13·9
,,	25	7	19	30				150	8	24·2
,,	,,	7	24	10	8	12	32·24			
,,	26	6	54	7	8	12	57·26	150	39	2·8
,,	,,	16	1	16	8	13	9·54	150	51	20·4
,,	,,	16	38	15	8	13	9·52			
,,	,,	16	57	42				150	52	7·3
,,	,,	17	0	26	8	13	8·63			
,,	,,	17	8	39				150	52	13·0
,,	29	17	16	25	8	14	13·69	152	20	3·0
Sept.	1	16	44	15	8	14	56·41	153	39	30·6
,,	8	7	40	22	8	15	0·20	156	17	37·5
,,	14	16	24	28	8	12	41·68	158	35	43·4
,,	,,	16	34	36	8	12	42·46	158	35	46·4
,,	21	11	45	56	8	6	44·83	160	51	22·8
,,	28	7	44	56	7	56	2·14	162	56	26·7
Oct.	2	9	51	38	7	46	46·72	164	5	44·2
,,	6	9	57	36	7	35	15·64	165	10	8·2
,,	,,	9	57	36	7	35	14·28			
,,	7	10	23	58	7	31	51·18			
,,	,,	10	23	58	7	31	51·32	165	24	9·4

Private Observatory, Windsor, N. S. Wales,
1875, *June* 3.

On the Form of the Tails of Comets. By M. de Fonvielle.

M. W. de Fonvielle has communicated a note "On the possibility of determining by a geometrical construction the form which the tails of Comets assume as seen from the Earth." The basis is Cardan's theory that the tail is produced by solar light refracted through the nucleus of the Comet, and subsequently reflected by solid and discontinuous particles of matter floating in almost every direction in infinite space. This theory was rejected by Kepler, on the ground that it was impossible to account by means of it for the curvature of the tail; M. de Fonvielle contends that, taking account of the finite velocity of light, the theory does in general give a curvature to the tail: viz. the tail as seen at any instant is, in fact, made up of elements of the tails due to a series of preceding positions of the Comet, being thus a plane curve (situate in the plane of the Comet's orbit), and which will accordingly be seen as a curved line; [viz. this will be the case if only the Earth is not in the plane of the Comet's orbit (that is, unless the orbit coincide with the Ecliptic, or the Earth be at the time of observation in the line of nodes)]. The construction for the figure of the tail in space is in effect as follows: the curve is the locus of a point, in the prolongation of the Comet's radius vector at a time preceding the observation, such that the distance of the point from the Comet (that is, the prolongation in question) *plus* the distance of the point from the Earth, is proportional to the interval up to the time of observation: and the curve can be in this manner constructed geometrically without much difficulty.

Elements of the Binary Stars, ζ Aquarii, 36 Andromedæ, and ι Leonis. By Dr. W. Doberck.

The elements are as follow:—

	ζ Aquarii.
T	1924·15
Node	140° 51′
λ	134° 40
γ	44° 42
Period	1578^{yrs}·33
a	7″·64
e	0·6518

36 *Andromedæ*.

T	1798·80
Node	57° 54′
λ	142° 19′
γ	41° 39′
Period	349^{yrs}·1
a	1″·54
e	0·6537.

ι *Leonis*.

Angle of Position = $93°{\cdot}75 - 0{\cdot}544\ (t-1830)$

Distance = $2''{\cdot}20 + 0''{\cdot}01\ (t-1830)$.

The Observations, and comparisons therewith of the Positions as calculated from the deduced elements, as well of the foregoing stars as of μ^2 *Boötis*, σ *Coronæ*, τ *Ophiuchi*, and γ *Leonis* (*Algieba*) (*see* pp. 373 and 397), are given in two papers published in the current volume (xiv.) of the *Transactions of the Royal Irish Academy*.

Discovery and Elements of Minor Planets (147) *and* (148).

Minor Planet (147), which has been named *Protogeneia*, was first seen by Dr. Schulhof, at Vienna, in the night of July 10–11, as a faint object of the 12th magnitude, which he estimated, at 13^h, to be distant about +3^s in R.A. and +3′ in Declination from a small star, No. 20510–1 of Oeltzen's Argelander's *Catalogue of Southern Stars*. On the following morning Dr. Schulhof was enabled to establish the suspected object as a new planet. Observations were obtained on the three following nights.

1875.	Mean Time at Vienna. h m s	Apparent R.A. h m s	L. f. p.	Apparent Dec. ° ′ ″	L. f. p.
July 11	12 59 23	20 19 22·78	6·636*n*	−17 29 53·6	9·959
12	13 55 55	20 18 36·06	8·076	−17 31 52·8	9·957
13	12 49 0	20 17 53·07	6·801*n*	−17 33 47·0	9·959

The following elements have been calculated by Dr. Schulhof from the observations made at Vienna on July 11, Pola and Vienna on July 26, and at Berlin, Leipzig, and Vienna on August 8 (*Ast. Nach.*, No. 2,052).

Epoch, 1875, July 11·5 Berlin Mean Time.

		°	′	″
M	=	215	53	52·9
π	=	84	43	1·6
☊	=	252	29	22·4
i	=	1	57	24·6
ϕ	=	1	41	36·7
μ	=	642″·174		
log a	=	0·494902.		

Minor planet (148) was discovered by M. Prosper Henry at Paris, on August 7. From observations made at Paris on August 7, and at Berlin on August 14 and 23, the following elements have been calculated by Herr Knorre (*Ast. Nach.*, No. 2,055).

Epoch, 1875, August 14·5087 Berlin Mean Time.

		°		″	
M	=	311	23	3·4	
ω	=	254	18	59·6	Mean Eq. 1875·0.
☊	=	145	18	4·1	
i	=	25	57	19·2	
ϕ	=	11	41	53·3	
μ	=	754″·525			
log a	=	0·448222.			

Errata.

The following ata have already been printed on the covers of Nos. 3 and 4:—

In the figure, p. 70, L should belong to the dotted line through D, instead of belonging to the adjacent line EB.

In Mr. Burnham's "Fifth Catalogue of Stars,"

Vol. xxxv., p. 45, No. 287, for ξ *Aquilæ* read ζ *Aquilæ.*

„ „ p. 46, No. 292, „ ν *Sagittarii* „ μ *Sagittarii.*

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